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JPA 1-218635

Specification

1. Title of the Invention:

Deodorant, Process for Producing Deodorant, Method of Deodorization, Deodorizing Apparatus, and Refrigeration Cycle Apparatus Provided with Deodorizing Apparatus

2. Claims:

1. A deodorant comprising an adsorbent and a photo-catalyst.

2. A deodorant comprising an adsorbent, a photo-catalyst and a second component containing at least one element of groups IIa, IIIa, IVa, Va, VIa, VIII, Ib, IIb, IIIb, and IVb.

3. The deodorant according to claim 1 or 2, wherein said adsorbent is at least one of activated carbon, alumina and silica, said photo-catalyst is at least one of TiO_2, SnO_2 and ZnO, and said second component contains at least one of Cu, Zn, La, Mo, V, Sr, Ag, Ba, Ce, Sn, Fe, W, Pt, Pd, Mg, and Al.

4. The deodorant according to any one of claims 1 to 3, wherein said deodorant contains 5 to 50 wt % of said photo-catalyst.

5. The deodorant according to claim 2 or 3, wherein said deodorant contains 0.5 to 40 wt % of said second component.

6. The deodorant according to any one of claims 1 to 5, wherein said deodorant formed is a porous state.

7. A process for manufacturing the deodorant according to any one of claims 1 to 6, wherein a mixture is sintered to form a porous state.

8. A method of deodorization, wherein the deodorant according to any one of claims 1 to 6 is irradiated with ultraviolet rays.

9. A deodorizing apparatus, wherein the deodorant according to any one of claims 1 to 6 is disposed around ultraviolet irradiation means placed in an air circulation pathway.

10. A deodorizing apparatus, wherein ultraviolet irradiation means is placed in an air circulation pathway, the deodorant according to any one of claims 1 to 6 is placed upstream of said air circulation pathway, and an adsorbent is placed downstream of said air circulation pathway.

11. A refrigeration cycle apparatus such as a refrigerator and an air conditioner, comprising the deodorizing apparatus according to claim 10 or 11.

3. Detailed Description of the Invention:

(Field of the Industrial Application)

The present invention relates to a deodorant, a method of deodorization and a deodorizing apparatus used for a refrigeration cycle apparatus such as a refrigerator and an air conditioner, and also to a process of manufacturing a deodorant, and further to a refrigeration cycle apparatus provided with the deodorizing apparatus.

(Prior Art)

Conventionally, activated carbon is used as a deodorant for a refrigeration cycle apparatus such as a refrigerator and an air conditioner (for example, Japanese Utility Model Laid-Open No. 47-22566).

In addition, conventional means is also available that is provided with a photo-catalyst such as TiO_2 and irradiates this photo-catalyst with ultraviolet rays to decompose foul-smelling components contained in the air for deodorization.

Moreover, conventional means is also available that is equipped with an ozone generation device and an ozone reaction device, which generate ozone to thereby decompose foul-smelling components for deodorization (for example, Japanese Patent Laid-Open No. 61-93381, Japanese Utility Model Laid-Open No. 61-205381).

(Problems to be Solved by the Invention)

However, the above-mentioned conventional method using activated carbon has such a problem that a deodorization effect can be maintained only for a short time due to saturation of adsorption capacity of the activated carbon when foul-smelling gases are present at a high

concentration.

Furthermore, for the conventional method for deodorization by irradiating a photo-catalyst with ultraviolet rays, continuous irradiation of the photo-catalyst with ultraviolet rays is required and the photo-catalyst is provided on only one side of ultraviolet irradiation means, and thus reaction efficiency of the catalyst is insufficient, leading to a problem of low deodorization efficiency.

To solve these problems, an object of the present invention is to provide a deodorant with high deodorization efficiency and capable of maintaining deodorization effect for a long time, a process of production thereof, a deodorizing method and a deodorizing apparatus, as well as a refrigeration cycle apparatus provided with the deodorizing apparatus.

(Means for Solving the Problems)

To achieve the above-mentioned object, a deodorant according to the present invention is characterized by comprising an adsorbent and a photo-catalyst. In addition, the deodorant is characterized by comprising a second component containing at least one element of groups IIa, IIIa, IVa, Va, VIa, VIII, Ib, IIb, IIIb, and IVb. Furthermore, the deodorant features a porous structure.

In addition, to achieve the above-mentioned object, a process for manufacturing a deodorant according to the present invention is characterized in that a mixture of the components of the above-mentioned deodorant is sintered to form a porous state.

Also, to achieve the above-mentioned object, a method of deodorization according to the present invention is characterized by irradiation of the above-mentioned deodorant with ultraviolet rays.

Also, a deodorizing apparatus according to the present invention for achieving the above-mentioned object is characterized in that the above-mentioned deodorant is disposed around ultraviolet irradiation means placed in an air circulation pathway. Furthermore, the apparatus is characterized in that ultraviolet irradiation means is placed in an air circulation pathway, the above-mentioned deodorant is placed upstream of this air circulation pathway, and an adsorbent is placed downstream of the air circulation pathway.

Additionally, a refrigeration cycle apparatus according to the present invention for achieving the above-mentioned object is characterized by comprising the above-mentioned deodorizing apparatus.

In the deodorant according to the present invention, at least one of activated carbon, alumina and silica can be used as an adsorbent. Also, at least one of n-type semiconductors such as TiO_2, SnO_2 and ZnO can be used as the above-mentioned photo-catalyst. In addition, the above-mentioned second component desirably contains at least one of Cu, Zn, La, Mo, V, Sr, Ag, Ba, Ce, Sn, Fe, W, Pt, Pd, Mg, and Al. The second component may be a simple substance, or a compound of nitrates, oxides, chlorides or sulfates thereof.

A photo-catalyst used for the above-mentioned deodorant according to the present invention is desirably contained in an amount of 5 to 50 wt %. When the amount is less than 5 wt %, efficiency in decomposition of foul-smelling components is decreased, while exceeding 50 wt % lowers a total amount of an adsorbent, leading to a decrease in adsorption capacity.

The second component used for the above-mentioned adsorbent according to the present invention is desirably contained in an amount of 0.5 to 40 wt %. This is because when the amount is less than 0.5 wt %, efficiency of decomposition of foul-smelling components decreases, while exceeding 40 wt % relatively lowers the amounts of an adsorbent and a photo-catalyst, leading to decreases in decomposition activity and adsorption capacity.

The deodorant according to the present invention is desirably porous in the form of honeycomb, plate, net or pellet. This is because rendering it a porous structure permits air containing foul-smelling components to enter the deodorant and also makes large a contact area between the foul-smelling components and the deodorant.

A process for manufacturing the above-mentioned deodorant relating to the present invention comprises the step of sintering a mixture of the above-mentioned deodorant components according to the present invention; the sintering temperature is desirably 500°C or lower. The reason is that sintering at 500°C or lower provides a stable photocatalytic activity. Also, another process, a photo-catalyst or a mixture of a photo-catalyst and a second component may be carried on an adsorbent.

Raw material of the photo-catalyst used for the adsorbent, for example TiO_2, includes titanium oxide, hydrated titanium oxides, titanium tetrachloride, titanium sulfate and organic titanium compounds.

The above-mentioned process for preparing a deodorant can involve the ordinarily used sedimentation methods, kneading methods, impregnating methods and evaporation solidification methods. Foul-smelling components decomposed and adsorbed by the deodorant include sulfur compounds, organic compounds and nitrogen compounds.

(Operation)

According to the above-mentioned deodorant containing an adsorbent and a photo-catalyst according to the present invention, foul-smelling component gases are adsorbed by the adsorbent and then irradiated with ultraviolet rays, that is to say, the photo-catalyst is irradiated with light of energy corresponding to a band gap or larger to thereby be excited, which generates electrons (or radicals) on a conduction band resulting in generation of holes (or radicals) in the valence band. These electrons and holes (or radicals) are dispersed in photo-catalyst particles reaching the surface, on which electrons are transferred between the surface and the foul-smelling components, thus decomposing the foul-smelling components. According to this deodorant according to the present invention, the foul-smelling component gases are adsorbed on the adsorbent and the photo-catalyst decomposes the foul-smelling components while the foul-smelling components are being adsorbed on the adsorbent. Therefore, as compared with the case where a photo-catalyst alone decomposes foul-smelling components, the decomposition efficiency is enhanced and also the adsorption efficiency can be kept for a long time resulting in an improved deodorization efficiency. In other words, irradiation of ultraviolet rays evaporates the foul-smelling components adsorbed in the adsorbent by means of its light energy, which reach pores in the photo-catalyst resulting in their decomposition.

Further addition of the above-mentioned second component to the deodorant enhances the decomposition efficiency of the photo-catalyst, thus making it possible to maintain deodorization efficiency for a long time.

Shaping the above-mentioned deodorant into a porous structure as discussed above increases a contact area between the foul-smelling components and the deodorant, thus enhancing deodorization efficiency.

Also, irradiation of the above-mentioned deodorant with ultraviolet rays can decompose foul-smelling components with a high decomposition efficiency, thus making it possible to provide a method of deodorization with a high deodorization effect.

In addition, according to the process of manufacturing a deodorant in which a mixture of the basic components of the above-mentioned deodorant is sintered to make porous, all foul-smelling components can be decomposed. On the other hand, when a deodorant is made by coating a photo-catalyst or a mixture of a photo-catalyst and a second component, of the foul-smelling components adsorbed in the adsorbent, the foul-smelling components adsorbed in the interior of the adsorbent in the absence of the photo-catalyst, etc. remain without decomposition because the photo-catalyst exists only on the surface of adsorbent.

A deodorizing apparatus, in which the above-mentioned deodorant is disposed around ultraviolet irradiation means, can utilize all ultraviolet rays for the deodorization reaction and thus improves deodorization efficiency.

In addition, according to the deodorizing apparatus in which the above-mentioned deodorant is placed in the upstream side and the adsorbent is placed in the downstream side, of decomposition products of foul-smelling components, relatively harmful substances, for example, including sulfur and alcohol, can be adsorbed in the downstream adsorption layer.

Furthermore, the refrigeration cycle apparatus of a refrigerator or an air conditioner equipped with this deodorizing apparatus can deodorize the air circulating in the apparatus with reliability.

(Examples)

Examples of the present invention will be described in the following.

(Example 1)

Examples discussed below show the test results on the adsorption capacities of prepared deodorants according to the present invention.

Example Deodorant 1

An aqueous solution in which 19 g of stannous oxide was dissolved was added to 100 g of hydrated titanium oxide (TiO_2 30%) and the solution was well mixed. A coating agent was prepared by adding distilled water to this mixed sol for dilution. An activated carbon honeycomb carrier (porous, 20 × 45 × 90) was coated 3 to 5 times with this coating agent. After coating, the material was dried at 150°C. Deodorant 1 was prepared by sintering the material at 300°C for 2 hours after drying. This deodorant contained 30 wt % of TiO_2 and 10 wt % of SnO_2 with respect to the activated carbon carrier.

Example Deodorant 2

A coating agent was prepared by adding distilled water to 100 g of hydrated titanium for dilution. An activated carbon honeycomb carrier was coated 3 to 5 times with this coating agent. After the coating, the material was dried at 150°C. Adsorbent 2 was prepared by sintering the material at 300°C for 2 hours after drying. This adsorbent contained 30 wt % of TiO_2 with respect to the activated carbon carrier.

Example Deodorants 3 to 5

Deodorants 3 to 5 were prepared by varying the amount of stannous oxide added in the preparation of Deodorant 1. The contents of stannous oxide in the Deodorants are each as follows:

Deodorant 3 TiO_2 - SnO_2 (1 wt %)

Deodorant 4 TiO_2 - SnO_2 (5 wt %)

Deodorant 5 TiO_2 - SnO_2 (20 wt %)

Comparative Example Deodorant 1

In the preparation method of Deodorant 2 above, an activated carbon honeycomb carrier uncoated with hydrated titanium was taken as Comparative Example 1 of Deodorant.

Example Deodorants 6 to 20

Example Deodorants 6 to 20 were prepared using instead of stannous chloride, respectively, copper nitrate, lanthanum nitrate, ammonium molybdate, zinc sulfate, ferric chloride, ammonium metavanadate, strontium nitrate, phosphorus nitrate, chloroplatinic acid,

magnesium nitrate, palladium nitrate, aluminium nitrate, barium nitrate, cerium nitrate, and ammonium paratungstate.

Measurement of breakthrough time

The deodorants thus prepared were placed in a box type case and dimethyl sulfide containing a foul-smelling component (500 ppm simulation gas) was flowed through.

The simulation gas was flowed until the above-mentioned honeycomb-shaped deodorants reached saturation adsorption for deterioration, and then the deodorants were irradiated with ultraviolet rays at 250 nm using a 4 W xenon lamp. After the simulation gas was decomposed and desorbed, the simulation gas was again flowed and the outflow of dimethyl sulfide was analyzed with a gas chromatograph.

The ability of the deodorants was evaluated from the breakthrough times of dimethyl sulfide before and after irradiation. Thus, the longer the breakthrough time and the smaller the difference between before and after the irradiation, the higher the decomposition activity. The breakthrough time refers to the time when the amount of adsorption becomes plateau in a graph in which the horizontal axis represents time and the vertical axis the amount of foul-smelling component gas adsorbed (per gram of catalyst).

The measurements of the breakthrough time are given in Table 1 below.

[Table 1]

#1 Example Deodorants

#2 Breakthrough time (minute)

#3 Before light irradiation

#4 After light irradiation

#5 Comparative Example Deodorant 1

#6 (Take white space below)

As can be seen from Table 1, Deodorants 1 to 20 readily decomposed after light irradiation as compared with Comparative Example Deodorant 1, the amounts of decomposition being almost equivalent to those in the cases before light irradiation. This result shows that the

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第1表

#1 実施例脱臭剤		#2 経過時間(分) 00 20 40 60 80 100
1	TiO_2-SnO_2	光照射前 #3 光照射後 #4
2	TiO_2	
3	TiO_2-SnO_2 (1%)	
4	TiO_2-SnO_2 (5%)	
5	TiO_2-SnO_2 (20%)	
6	TiO_2-CuO	
7	TiO_2-ZnO	
8	$TiO_2-Fe_2O_3$	
9	$TiO_2-La_2O_3$	
10	TiO_2-MoO_3	
11	$TiO_2-V_2O_5$	
12	TiO_2-SeO	
13	TiO_2-Ag_2O	

第1表

実施例脱臭剤		経過時間(分) 00 20 40 60 80 100
14	TiO_2-PtO	
15	TiO_2-PdO	
16	TiO_2-AgO	
17	$TiO_2-Al_2O_3$	
18	TiO_2-BaO	
19	TiO_2-CeO_2	
20	TiO_2-WO_3	
比較例脱臭剤 1 #5		

(以下余白) #6

deodorants relating to the present embodiments have high decomposition activities and large deodorization capacities. Also, they can maintain the deodorization capacities for a long time.

In addition, Table 1 also indicates that the cases with further addition of second components exhibit higher deodorization effects than the case where a deodorant is coated with a photo-catalyst alone (Example Deodorant 2).

(Example 2)

In this example, prepared deodorants were tested for the adsorption capabilities thereof after completion of the method for preparing the deodorant.

Example Deodorant 21

Activated carbon with a specific surface area of 1250 m^2/g was mixed with hydrated TiO_2 sol (TiO_2 content of 30 wt %) and to this was added 5 wt % of PVA (polyvinyl alcohol), an adhesive. This mixture was made honeycomb-like, and then was sintered at 500°C to yield Example Deodorant 21. The final content of TiO_2 was 20 wt %.

A foul-smelling simulation gas (dimethyl sulfide 500 ppm) was passed through this deodorant, and while adsorbing the gas the concentration of the gas at the outlet was analyzed. The time when the outlet gas reached a concentration of 500 ppm was determined. This was taken as the saturation time T. Table 2 below shows the first required time T_a and the time T_1 when the simulation gas was once again adsorbed after the adsorption gas was decomposed by light irradiation. The equivalence of T_a and T_1 shows that the initially adsorbed gas was decomposed by light irradiation and the amount of gas adsorbed at T_1 was the same as that at T_a. In addition, the amount of adsorption was 2 % (relative to that of the deodorant).

[Table 2]

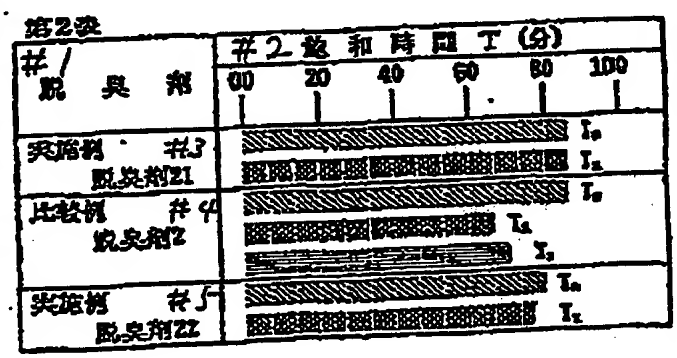
#1 Deodorants

#2 Saturation time T (minute)

#3 Example Deodorant 21

#4 Comparative Example Deodorant 2

#5 Example Deodorant 22



Comparative Example Deodorant 2

A commercially available activated carbon honeycomb was coated with hydrated TiO_2 sol (TiO_2 content of 30 wt %) by impregnation. This was sintered at 500°C to give Comparative Example Deodorant 2. The final content of TiO_2 was 20 wt %. Using this deodorant in the amount equivalent to that of Example Deodorant 21 above, the saturation times T_a and T_1 were measured by means of the same method as in Example Deodorant 21 above. For the T_a, the percentage of the saturation adsorption amount was 2 %. Further, after T_1 measurement, the deodorant was irradiated with light to decompose the adsorption gas and then was allowed to adsorb the simulation gas to measure T_2. For the T_1 and T_2, the percentages of the saturation adsorption amount were 1.5 %. Table 2 shows T_a, T_1, and T_2. Decreases of T_1 and T_2 compared with T_a indicate that after decomposition of the gas once adsorbed the amount of adsorption is decreased in Comparative Example Deodorant 2. Also, the equivalence of the T_1 and the T_2 shows that a constant amount of gas remains in this deodorant without decomposition by light irradiation. This is because coating of an activated carbon honeycomb with a photo-catalyst generates an activated carbon portion without the photo-catalyst, while due to the mixture of the photo-catalyst and the adsorbent being made honeycomb-like in Example Deodorant 21 above, the photo-catalyst uniformly contacts the adsorbent to be able to reliably decompose the foul-smelling gas components adsorbed in the adsorbent.

Example Deodorant 22

Activated carbon and hydrated TiO_2 sol were mixed as in the case of Example Deodorant 21 and to this was added PVA to yield slurry. This slurry was applied to a wire gauze and the slurry applied gauze was subjected to drying, followed by sintering at 500°C to give a plate-like deodorant. The saturation times T_a and T_1 of this deodorant were measured using the same amount and method as in Example Deodorant 21. The percentage of the saturation adsorption amount was 2 %. The T_a and T_1 are shown in Table 2. Table 2 indicates that the deodorant with a plate-like shape offers an effect similar to one with a honeycomb-like shape of Example Deodorant 21.

So far, honeycomb and plate shapes of deodorants were discussed in the examples and the

deodorant can also be made pellet-like. In this case, a plurality of pellet-like deodorants are placed in a given container and deodorization is conducted by passing a foul-smelling gas through this container.

(Example 3)

This example will discuss an example of the deodorizing apparatus constructed by disposing the above-mentioned deodorant around ultraviolet irradiation means.

Figure 1 shows a cross-sectional view of an example of the deodorizing apparatus.

Referring to Figure 1, an ultraviolet ray lamp 2 is placed in a box type deodorization case 1 as ultraviolet irradiation means. This ultraviolet ray lamp 2 is disposed at a place of a pathway for externally introduced air. In the upstream and downstream sides of this ultraviolet ray lamp 2, and thus in the front and back of the ultraviolet ray lamp 2, a deodorant layer 3 having placed the above-mentioned deodorant therein is disposed. A suction fan 4 is placed downstream of this deodorant layer 3.

In a deodorizing apparatus configured like this, as the suction fan 4 rotates, air A containing a foul-smelling gas is passed through the deodorant layer 3 and the foul-smelling gas components are adsorbed and then decomposed by the action of the ultraviolet ray lamp 2. As a result, deodorized air C is discharged outside the system.

According to the above-mentioned example, ultraviolet rays from the ultraviolet ray lamp 2 can be effectively utilized in the deodorant layer disposed in its front and back, and so deodorization efficiency is improved. Also, foul-smelling components can be reliably adsorbed and decomposed and deodorization effect can be maintained for a long time because the deodorizing layer 3 is doubly placed.

(Example 4)

In this example, an example of the deodorizing apparatus having disposed an adsorbing layer 4 downstream of the above-mentioned deodorant 3 will be described. Figure 2 shows a cross-sectional view of an example of the deodorizing apparatus.

Referring to Figure 2, descriptions are omitted for the same portions as those in Figure 1 by denoting the same reference numerals. A deodorizing apparatus shown in Figure 2 disposes

the above-mentioned deodorant layer 3 downstream of the ultraviolet ray lamp 2 and further disposes an adsorbing layer 20 downstream of the deodorant layer 3. In this example, the photo-catalyst of the deodorant layer 3 is excited by the irradiation via the ultraviolet ray lamp 2 to decompose foul-smelling components, thereby generating decomposition gas B. This decomposition gas B is almost completely adsorbed in the adsorbing layer 4 in the downstream side to yield reliably deodorized air C.

Sulfur compounds, nitrogen compounds, organic compounds are contained in the air as foul-smelling components, which are decomposed in the deodorant layer 3 as was discussed above. While these gases generated after the decomposition do not have foul smells, they are harmful in some cases. Setting up an adsorbing layer 20 in the downstream side can almost completely adsorb the decomposition products of the foul-smelling components. Therefore, complete deodorization is achieved.

In addition, irradiation by the ultraviolet ray lamp 2 can be intermittently lighted, continuously lighted, or lighted artificially from outside.

Next, deodorization performance was examined using the deodorizing apparatus described in Figure 2 above. This examination used a simulation gas for a foul-smelling gas (dimethyl sulfide 500 ppm - N_2). Figure 3 shows the result.

As shown in Figure 3, passage of the simulation gas through the air deodorizing apparatus increases the concentration of the simulation gas with time, and eventually the simulation gas flows out due to adsorption saturation. The gas after the flowing out was analyzed by gas chromatograph. Then, when irradiation was carried out by the ultraviolet ray lamp, as shown in Figure 2, the simulation gas at the outlet of the adsorbing layer did not flow out for a long while, indicating that the deodorization performance of the deodorizing apparatus based on the example is good.

(Effect of the Invention)

As discussed above, a deodorant containing an adsorbent and a photo-catalyst according to the present invention can adsorb foul-smelling component gases and then decompose them and thus can improve the deodorization efficiency and maintain the deodorization effect for a

long while.

In addition, the present invention to which a second component, which improves the photo-catalyst activity, is added, further improves the decomposition efficiency of foul-smelling components and can maintain the deodorization effect for a long while.

Also, the present invention formed by making porous the above-mentioned deodorant renders the passage of air into the deodorant good and also enlarges the contact area between the foul-smelling component gases and the deodorant, thus enhancing the deodorization effect.

In addition, the present invention formed by making porous via the sintering of a mixture of each component of the deodorant mixes an adsorbent with a photo-catalyst uniformly, and therefore can completely decompose the foul-smelling components adsorbed.

Also, the method of deodorization according to the present invention that irradiates the above-mentioned deodorant with ultraviolet rays, can efficiently decompose and deodorize foul-smelling component gases for a long while.

Also, the present invention that disposes the above-mentioned deodorant around ultraviolet irradiation means placed in the air circulation pathway, enlarges the area of the deodorant irradiated with ultraviolet rays, leading to improvement in deodorization efficiency.

Also, the deodorizing apparatus according to the present invention that disposes the above-mentioned deodorant upstream of the air circulation pathway and disposes the adsorbent in the downstream side, can almost completely remove the decomposition products of foul-smelling component gases decomposed by the adsorbent by means of the adsorbent, thus can conduct complete deodorization.

Furthermore, the present invention relating to refrigeration cycle apparatuses provided with the above-mentioned deodorizing apparatus such as a refrigerator and an air conditioner, can completely deodorize these apparatuses and thus facilitate their utilization.

4. Brief Description of the Drawings:

Figure 1 shows a cross-sectional view of an example of the deodorizing apparatus according to the present invention, Figure 2 shows a cross-sectional view of another example of

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the deodorizing apparatus, and Figure 3 shows a graph that indicates the result of the deodorization performance studied using the apparatus shown in Figure 2.

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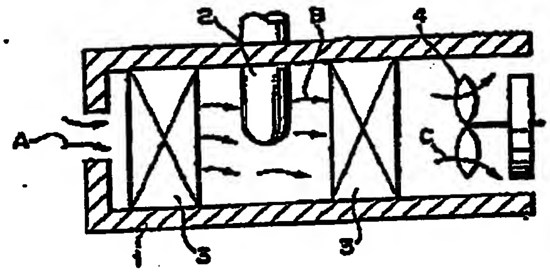
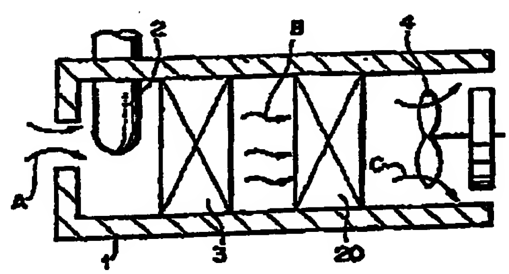
FIG. 1



1: Box type deodorization case
2: Ultraviolet ray lamp
3: Deodorant layer
4: Suction fan

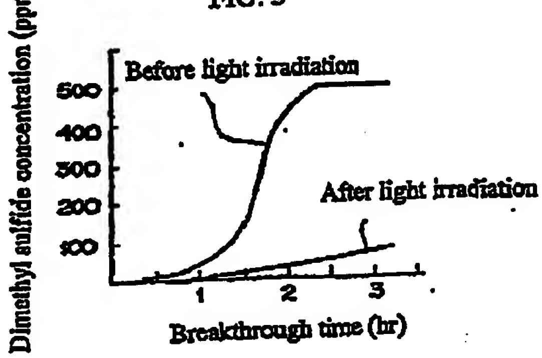
A: foul-smelling gas
B: Decomposition gas
C: Deodorized air

FIG. 2



20 ... Suction layer

FIG. 3



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Specification

1. Title of the Invention:

Deodorant, Process for Producing Deodorant, Method of Deodorization, Deodorizing Apparatus, and Refrigeration Cycle Apparatus Provided with Deodorizing Apparatus

2. Claims:

1. A deodorant comprising an adsorbent and a photo-catalyst.

2. A deodorant comprising an adsorbent, a photo-catalyst and a second component containing at least one element of groups IIa, IIIa, IVa, Va, VIa, VIII, Ib, IIb, IIIb, and IVb.

3. The deodorant according to claim 1 or 2, wherein said adsorbent is at least one of activated carbon, alumina and silica, said photo-catalyst is at least one of TiO_2, SnO_2 and ZnO, and said second component contains at least one of Cu, Zn, La, Mo, V, Sr, Ag, Ba, Ce, Sn, Fe, W, Pt, Pd, Mg, and Al.

4. The deodorant according to any one of claims 1 to 3, wherein said deodorant contains 5 to 50 wt % of said photo-catalyst.

5. The deodorant according to claim 2 or 3, wherein said deodorant contains 0.5 to 40 wt % of said second component.

6. The deodorant according to any one of claims 1 to 5, wherein said deodorant formed is a porous state.

7. A process for manufacturing the deodorant according to any one of claims 1 to 6, wherein a mixture is sintered to form a porous state.

8. A method of deodorization, wherein the deodorant according to any one of claims 1 to 6 is irradiated with ultraviolet rays.

9. A deodorizing apparatus, wherein the deodorant according to any one of claims 1 to 6 is disposed around ultraviolet irradiation means placed in an air circulation pathway.

10. A deodorizing apparatus, wherein ultraviolet irradiation means is placed in an air circulation pathway, the deodorant according to any one of claims 1 to 6 is placed upstream of said air circulation pathway, and an adsorbent is placed downstream of said air circulation pathway.

11. A refrigeration cycle apparatus such as a refrigerator and an air conditioner, comprising the deodorizing apparatus according to claim 10 or 11.

3. Detailed Description of the Invention:

(Field of the Industrial Application)

The present invention relates to a deodorant, a method of deodorization and a deodorizing apparatus used for a refrigeration cycle apparatus such as a refrigerator and an air conditioner, and also to a process of manufacturing a deodorant, and further to a refrigeration cycle apparatus provided with the deodorizing apparatus.

(Prior Art)

Conventionally, activated carbon is used as a deodorant for a refrigeration cycle apparatus such as a refrigerator and an air conditioner (for example, Japanese Utility Model Laid-Open No. 47-22566).

In addition, conventional means is also available that is provided with a photo-catalyst such as TiO_2 and irradiates this photo-catalyst with ultraviolet rays to decompose foul-smelling components contained in the air for deodorization.

Moreover, conventional means is also available that is equipped with an ozone generation device and an ozone reaction device, which generate ozone to thereby decompose foul-smelling components for deodorization (for example, Japanese Patent Laid-Open No. 61-93381, Japanese Utility Model Laid-Open No. 61-205381).

(Problems to be Solved by the Invention)

However, the above-mentioned conventional method using activated carbon has such a problem that a deodorization effect can be maintained only for a short time due to saturation of adsorption capacity of the activated carbon when foul-smelling gases are present at a high

concentration.

Furthermore, for the conventional method for deodorization by irradiating a photo-catalyst with ultraviolet rays, continuous irradiation of the photo-catalyst with ultraviolet rays is required and the photo-catalyst is provided on only one side of ultraviolet irradiation means, and thus reaction efficiency of the catalyst is insufficient, leading to a problem of low deodorization efficiency.

To solve these problems, an object of the present invention is to provide a deodorant with high deodorization efficiency and capable of maintaining deodorization effect for a long time, a process of production thereof, a deodorizing method and a deodorizing apparatus, as well as a refrigeration cycle apparatus provided with the deodorizing apparatus.

(Means for Solving the Problems)

To achieve the above-mentioned object, a deodorant according to the present invention is characterized by comprising an adsorbent and a photo-catalyst. In addition, the deodorant is characterized by comprising a second component containing at least one element of groups IIa, IIIa, IVa, Va, VIa, VIII, Ib, IIb, IIIb, and IVb. Furthermore, the deodorant features a porous structure.

In addition, to achieve the above-mentioned object, a process for manufacturing a deodorant according to the present invention is characterized in that a mixture of the components of the above-mentioned deodorant is sintered to form a porous state.

Also, to achieve the above-mentioned object, a method of deodorization according to the present invention is characterized by irradiation of the above-mentioned deodorant with ultraviolet rays.

Also, a deodorizing apparatus according to the present invention for achieving the above-mentioned object is characterized in that the above-mentioned deodorant is disposed around ultraviolet irradiation means placed in an air circulation pathway. Furthermore, the apparatus is characterized in that ultraviolet irradiation means is placed in an air circulation pathway, the above-mentioned deodorant is placed upstream of this air circulation pathway, and an adsorbent is placed downstream of the air circulation pathway.

Additionally, a refrigeration cycle apparatus according to the present invention for achieving the above-mentioned object is characterized by comprising the above-mentioned deodorizing apparatus.

In the deodorant according to the present invention, at least one of activated carbon, alumina and silica can be used as an adsorbent. Also, at least one of n-type semiconductors such as TiO_2, SnO_2 and ZnO can be used as the above-mentioned photo-catalyst. In addition, the above-mentioned second component desirably contains at least one of Cu, Zn, La, Mo, V, Sr, Ag, Ba, Ce, Sn, Fe, W, Pt, Pd, Mg, and Al. The second component may be a simple substance, or a compound of nitrates, oxides, chlorides or sulfates thereof.

A photo-catalyst used for the above-mentioned deodorant according to the present invention is desirably contained in an amount of 5 to 50 wt %. When the amount is less than 5 wt %, efficiency in decomposition of foul-smelling components is decreased, while exceeding 50 wt % lowers a total amount of an adsorbent, leading to a decrease in adsorption capacity.

The second component used for the above-mentioned adsorbent according to the present invention is desirably contained in an amount of 0.5 to 40 wt %. This is because when the amount is less than 0.5 wt %, efficiency of decomposition of foul-smelling components decreases, while exceeding 40 wt % relatively lowers the amounts of an adsorbent and a photo-catalyst, leading to decreases in decomposition activity and adsorption capacity.

The deodorant according to the present invention is desirably porous in the form of honeycomb, plate, net or pellet. This is because rendering it a porous structure permits air containing foul-smelling components to enter the deodorant and also makes large a contact area between the foul-smelling components and the deodorant.

A process for manufacturing the above-mentioned deodorant relating to the present invention comprises the step of sintering a mixture of the above-mentioned deodorant components according to the present invention; the sintering temperature is desirably 500°C or lower. The reason is that sintering at 500°C or lower provides a stable photocatalytic activity. Also, another process, a photo-catalyst or a mixture of a photo-catalyst and a second component may be carried on an adsorbent.

Raw material of the photo-catalyst used for the adsorbent, for example TiO_2, includes titanium oxide, hydrated titanium oxides, titanium tetrachloride, titanium sulfate and organic titanium compounds.

The above-mentioned process for preparing a deodorant can involve the ordinarily used sedimentation methods, kneading methods, impregnating methods and evaporation solidification methods. Foul-smelling components decomposed and adsorbed by the deodorant include sulfur compounds, organic compounds and nitrogen compounds.

(Operation)

According to the above-mentioned deodorant containing an adsorbent and a photo-catalyst according to the present invention, foul-smelling component gases are adsorbed by the adsorbent and then irradiated with ultraviolet rays, that is to say, the photo-catalyst is irradiated with light of energy corresponding to a band gap or larger to thereby be excited, which generates electrons (or radicals) on a conduction band resulting in generation of holes (or radicals) in the valence band. These electrons and holes (or radicals) are dispersed in photo-catalyst particles reaching the surface, on which electrons are transferred between the surface and the foul-smelling components, thus decomposing the foul-smelling components. According to this deodorant according to the present invention, the foul-smelling component gases are adsorbed on the adsorbent and the photo-catalyst decomposes the foul-smelling components while the foul-smelling components are being adsorbed on the adsorbent. Therefore, as compared with the case where a photo-catalyst alone decomposes foul-smelling components, the decomposition efficiency is enhanced and also the adsorption efficiency can be kept for a long time resulting in an improved deodorization efficiency. In other words, irradiation of ultraviolet rays evaporates the foul-smelling components adsorbed in the adsorbent by means of its light energy, which reach pores in the photo-catalyst resulting in their decomposition.

Further addition of the above-mentioned second component to the deodorant enhances the decomposition efficiency of the photo-catalyst, thus making it possible to maintain deodorization efficiency for a long time.

Shaping the above-mentioned deodorant into a porous structure as discussed above increases a contact area between the foul-smelling components and the deodorant, thus enhancing deodorization efficiency.

Also, irradiation of the above-mentioned deodorant with ultraviolet rays can decompose foul-smelling components with a high decomposition efficiency, thus making it possible to provide a method of deodorization with a high deodorization effect.

In addition, according to the process of manufacturing a deodorant in which a mixture of the basic components of the above-mentioned deodorant is sintered to make porous, all foul-smelling components can be decomposed. On the other hand, when a deodorant is made by coating a photo-catalyst or a mixture of a photo-catalyst and a second component, of the foul-smelling components adsorbed in the adsorbent, the foul-smelling components adsorbed in the interior of the adsorbent in the absence of the photo-catalyst, etc. remain without decomposition because the photo-catalyst exists only on the surface of adsorbent.

A deodorizing apparatus, in which the above-mentioned deodorant is disposed around ultraviolet irradiation means, can utilize all ultraviolet rays for the deodorization reaction and thus improves deodorization efficiency.

In addition, according to the deodorizing apparatus in which the above-mentioned deodorant is placed in the upstream side and the adsorbent is placed in the downstream side, of decomposition products of foul-smelling components, relatively harmful substances, for example, including sulfur and alcohol, can be adsorbed in the downstream adsorption layer.

Furthermore, the refrigeration cycle apparatus of a refrigerator or an air conditioner equipped with this deodorizing apparatus can deodorize the air circulating in the apparatus with reliability.

(Examples)

Examples of the present invention will be described in the following.

(Example 1)

Examples discussed below show the test results on the adsorption capacities of prepared deodorants according to the present invention.

[redacted]

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L2 ANSWER 1 OF 1 WPINDEX (C) 2002 THOMSON DERWENT

ACCESSION NUMBER: 1989-296646 [41] WPINDEX
DOC. NO. NON-CPI: N1989-226148
DOC. NO. CPI: C1989-131265
TITLE: Deodorant contains adsorbent and photo-catalyst - and deodorising equipment used in refrigeration cycle appts..
DERWENT CLASS: D22 J01 Q75
PATENT ASSIGNEE(S): (HITA) HITACHI LTD
COUNTRY COUNT: 1
PATENT INFORMATION:

PATENT NO	KIND	DATE	WEEK	LA	PG	MAIN IPC	
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JP 06102155	B2	19941214	(199503)		9	B01J020-28	

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PRIORITY APPLN. INFO: JP 1988-47141 19880229
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BASIC ABSTRACT:
JP 01218635 A UPAB: 19930923
This deodorant is characterised by contg. adsorbent and photocatalyst. Pref. the deodorant contains adsorbent, photocatalyst and the second component including at least one element selected from Gp. IIa, IIIa, IVa, Va, VIa, VIII, Ib, IIb, IIIb and IVb. Pref. the adsorbent is at least one selected from activated carbon, alumina and silica. The photocatalyst is at least one selected from TiO_2, SnO_2 and ZnO. The second component contains at least one selected from Cu, Zn, La, Mo, V, Sr, Ag, Ba, Ce, Sn, Fe, W, Pt, Pd, Mg and Al. A content of the photocatalyst is 5 to 50 wt.% of the deodorant. A content of the 2nd component is 0.5 to 40 wt.% of deodorant. The deodorant is formed in porous state. The deodorant is irradiated by UV ray. The device for the UV ray irradiation is fixed in the path of the air circulation. In addn., the deodorant is located on the up-stream of the path of the air circulation, and the adsorbent on the down-stream. The equipment with refrigeration cycle for the refrigerator, air conditioner, etc., provided with the deodorisation equipment.

ADVANTAGE - Because the adsorption and decomposition of odour take place separately on the catalyst, the efficiency of deodorisation is improved and the deodorising performance can be maintained for a long

time.
0/3
FILE SEGMENT: CPI GMPI
FIELD AVAILABILITY: AB
MANUAL CODES: CPI: D09-B; J01-E03C; J01-E03F; N01-B; N01-C; N02; N03